Hydro-Thermal Vent Mapping with Multiple AUV's

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LONG TERM GOAL

The Naval Postgraduate School (NPS) and the Instituto Superior Technico, Lisbon (IST) have a long standing memorandum of agreement dating back to 1994 for the exchange of scientific ideas, visits of faculty and students, and to perform collaborative work. In the past we have collaborated on joint papers, the shared supervision of doctoral work, and a shared effort on the evaluation of AUV control system methodology and strategic level mission specifications using Petri net methods. This is a NICOP project aimed at developing the technology of multiple cooperating AUV's in a shallow water vent mapping mission. The mission will develop multi vehicle cooperative strategies and control using radio and acoustic communications. Results of both sonar and video images will be obtained in which the Portuguese vehicle - MARIUS and a surface catamaran (AZIMOV) will perform broad are survey to identify vent clusters, while the NPS vehicle - ARIES will reaquire vent cluster locations and perform close in data gathering.

OBJECTIVES

The IST has recently been approved to conduct a mission in the Azores (the AZIMOV project) using cooperative behaviors between a surface catamaran vehicle and an underwater vehicle (Marius). The project involves the French company ORCA, and personnel within the GESMA (French Navy), as well as faculty from IST The major goal of the mission is to map areas in the shallow water areas of the Azores containing hydrothermal vents. The waters are shallow (10 - 20 meters) and large clusters of these vents are known to exist. While there is a scientific need to study the vents with more detail than possible using divers and cameras, this also presents a parallel to the mine field reconnaissance and mapping problem in very shallow water - so necessary to the US Navy.

The strategy for mapping these shallow water vent areas will be to employ a combination of low resolution sensors (sonars) on one vehicle (Marius) to detect the presence of extensive clusters of vents, and to communicate the cluster location data information to the NPS ARIES AUV, which will have the capability to reaquire the vent area using high resolution sonar and to conduct a survey of the local area with both sonar and a video camera. ARIES would combine its hovering ability with an upgraded ability to control ballast to ground the vehicle on bottom while taking video so that energy would be conserved. While ARIES is performing video operations, Marius will continue searching for further clusters of vents until the area is fully mapped.

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APPROACH

The development of ARIES follows from the earlier work at NPS using the Phoenix vehicle in shallow waters. A study has been conducted relating to station keeping under waves and wave effects on vehicle motion. The gathering of shallow water wave data has been accomplished in the doctoral dissertation of LCDR J. S. Riedel where it has been demonstrated that station keeping to within 20 cm. was achieved under sea state 2-3 conditions in Monterey Bay. Further experiments are planned in FY2000 to obtain video images of vent-like bubble streams artificially placed in the sea bottom in Monterey Bay. Area reacquisition is being developed using DGPS / Acoustic Doppler / INS navigation system and will be tested at AUVFEST 99 in Gulfport Mississippi November 2-9, 1999. Finally, control cooperation will be accomplished using acoustic communication links established between the ARIES and the AZIMOV vehicles in a field experiment in 2001.

WORK COMPLETED

In shallow water areas, the influence of waves and currents must be considered for their effects on vehicle motion. Slow motion or stationkeeping is needed to obtain video pictures of bubble streams and the doctoral dissertation of Jeff Riedel addresses both the modeling of wave characteristics from a vehicle response and control point of view, as well as experimentally validated algorithms using a new wave effects filter for improved station keeping behaviors. Also, during FY 99, NPS participated in AUVFEST 98 (see http://web.nps.navy.mil/~me/healey/AUVFEST98_report.pdf).

Another piece of this project is to develop a soft grounding capability in ARIES so that bottom sitting behaviors could be utilized as needed in the acquisition of sonar and video imagery. A study of controlled weight ballasting has been undertaken in the MS thesis work of LT Beyazay and a design produced. Experimental validation of this capability remains to be accomplished.

NEW TECHNOLOGY TO BE DEMONSTRATED

(1) Multi vehicle cooperation via data sharing
(2) Shallow water target reacquisition
(3) Shallow water object mapping
(4) Auto buoyancy compensation and station keeping by soft grounding
(5) Coordinated Mission Control.

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